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VERIFICATION OF TRANSLATION

I hereby declare and state that I am knowledgeable of the Japanese and English languages and that I made and reviewed the attached translation of the attached patent application entitled "REWRITING SYSTEM FOR VEHICLE CONTROLLER" from the Japanese language into the English language, and that I believe my attached translation to be accurate, true, and correct to the best of my knowledge and ability.

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Date:

Signature

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JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this Office.

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Object:	Specification	1
Object:	Drawings	1
Object:	Abstract	1

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[Document Name] Specification

[Title of the Invention] Rewriting system for vehicle controller

[Claims]

[Claim 1] A rewriting system for rewriting data stored in a memory of a vehicle controller with new data transferred from a rewriting device, the rewriting device comprising an offline determination means for determining that communication is offline if a response time of the vehicle controller exceeds a first predetermined time and an offline prohibiting means for prohibiting the offline determination until a response time of the vehicle controller exceeds the first predetermined time and then reaches a second predetermined time when deleting or writing operation on the memory is being performed.

[Claim 2] The rewriting system of claim 1, wherein the rewriting device further comprises a means for acquiring from the vehicle controller a time necessary to delete the data in the memory or write the new data into the memory prior to the deleting or writing operation, wherein, when the deleting operation is performed, the acquired time necessary to delete the data in the memory is set in the second predetermined time, and wherein, when the writing operation is performed, the acquired time necessary to write the new data into the memory is set in the second predetermined time.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a system for rewriting a program stored in a memory of a vehicle controller with other program transferred from an external rewriting device.

[0002]

[Prior Art]

Vehicles are subjected to various types of control by electronic control units (hereafter referred to as "ECU"). Such control includes engine-related control of an air fuel ratio, fuel injection amount, and emission as well as body-related control of a power window, an air bag, and an ABS. The ECU provides various types of control for the vehicle based on current conditions and traveling conditions of the vehicle sensed by various sensors mounted on the vehicle.

[0003]

The ECU comprises a central processing unit (CPU), a ROM (Read Only Memory) that stores programs and data to be executed, a RAM (Random Access Memory) which provides a work area for execution and which stores results of computation, and an input/output interface for receiving signals from various sensors and transmitting control signals to various parts of the engine.

[0004]

A system is known wherein a rewritable and non-volatile memory, such as a flash memory, an EEPROM ,is used as the ROM to allow data stored in the ROM to be rewritten. Such a system typically comprises a rewriting device, an ECU and a serial communication path connecting them together. Rewriting is achieved by deleting data stored in the non-volatile memory mounted on the ECU and writing new data transferred from the rewriting device via serial communication into the memory. By way of example, Japanese Patent Application Laid-Open No. 63-223901 describes a method for changing a program stored in the EEPROM of the ECU in response to a request from an external device via

a SCI (Serial Communication Interface) terminal with the ECU being mounted on the vehicle.

[0005]

Generally, deleting and writing operation on a non-volatile memory such as a flash memory and EEPROM requires a relatively large amount of time. When there is no response from the ECU for a predetermined period, the rewriting device determines that communication between the ECU and the rewriting device is offline. A typical method wherein the rewriting device acquires the result of the deleting operation or writing operation after they are initiated is shown in FIGS. 6 and 7. FIG. 6 is a flow chart showing the deleting and writing process performed by the rewriting device, and FIG. 7 is a flow chart showing the deleting and writing process performed by the ECU.

[0006]

In response to a request for deleting operation or writing operation from the rewriting device (step 501 or 521), the ECU sends a signal to the rewriting device indicative of start of deleting operation or writing operation (step 552 or 562) and performs the deleting or writing operation (step 553 or 563). In response to the signal indicative of start of deleting operation or writing operation, the rewriting device requests the result of the deleting operation or writing operation (step 505 or 525). If the deleting operation or writing operation is being performed, the ECU sends a signal to the rewriting device indicating that the deleting operation or writing operation is in progress (step 556 or 566). If the deleting operation or writing operation has been completed, the ECU sends a signal indicative of completion of the deleting operation or writing operation (step 557 or 567).

[0007]

At step 509 or 529, if the response from the ECU indicates that the deleting or writing operation is in progress, the process returns to step 505 or 525. If the response from the ECU indicates that the deleting or writing operation has been completed, the process proceeds to the following step 510 or 530. In this way, the rewriting device determines whether deleting or writing operation is being performed or has been completed by sending a request for the result of the deleting or writing operation and by receiving a response to the request. Even if the deleting or writing operation is being performed, an erroneous determination of offline is not made as long as there is a response from the ECU.

[0008]

FIG. 8 shows typical two forms of a non-volatile memory mounted on the ECU. FIG. 8(a) shows a form in which a flash memory 16, which is a non-volatile memory, is provided independently of a CPU 14. In other words, the flash memory 16 is mounted on a chip different from the CPU 14. The flash memory 16 is coupled to a chip of a microcomputer where the CPU is mounted via an external bus 5. When the ECU 10 receives a request for deleting or writing operation on the flash memory 16 from the rewriting device 11, the deleting or writing operation on the flash memory is performed by an input/output controller (not shown) that controls input/output through the external bus 5. In this way, since deleting or writing control on the flash memory is performed independently of the CPU, the CPU does not become busy during deleting or writing operation.

[0009]

FIG. 8(b) shows another form in which the flash memory 16 and the CPU 14 are provided on a single chip to constitute one chip

microcomputer. The flash memory 16 is coupled to the CPU 14 via an internal bus 7. Deleting or writing operation is performed by an interface means incorporated in the CPU as a function. In this case, the CPU may become busy during deleting or writing operation. When the CPU is busy, the ECU 10 may be unable to communicate with the rewriting device 11.

[0010]

[Problems to be Solved by the Invention]

Recently, in order to reduce costs relating to the ECU, a microcomputer including a non-volatile memory, as shown in FIG. 8(b), has been increasingly employed. As described above, in this form, a CPU may become busy during deleting or writing operation on a non-volatile memory. When the ECU is busy, it may not respond to a request for the result of deleting or writing operation from the rewriting device. As a result, even though the communication line is normal, the rewriting device may erroneously determine that the communication is offline if a response from the ECU has not been received within a predetermined period.

[0011]

Therefore, the invention solves the above problems. It is an object of the invention to provide a rewriting system capable of avoiding an erroneous determination of offline when deleting or writing operation on a non-volatile memory is being performed in the ECU.

[0012]

[Means to Solve the Problem]

In order to solve the above problems, the invention as defined in claim 1 provides a rewriting system for rewriting data stored in a memory of a vehicle controller with new data transferred from a rewriting device,

the rewriting device comprising an offline determination means for determining that the communication is offline if a response time of the vehicle controller exceeds a first predetermined and an offline prohibiting means for prohibiting the offline determination until a response time of the vehicle controller exceeds the first predetermined time and then reaches a second predetermined time when deletion or writing operation on the memory is being performed.

[0013]

According to the invention of claim 1, an erroneous determination that the communication line is offline can be avoided when deleting or writing operation on a memory of the vehicle controller is being performed.

[0014]

The invention as defined in claim 2 provides the rewriting system of claim 1, wherein the rewriting device further comprises a means for acquiring from the vehicle controller a time necessary to delete the data in the memory or write the new data into the memory prior to the deleting or writing operation, wherein, when the deleting operation is performed, the acquired time necessary to delete the data in the memory is set in the second predetermined time, and wherein, when the writing operation is performed, the acquired time necessary to write the new data into the memory is set in the second predetermined time.

[0015]

According to the invention of claim 2, since an offline determination is made based on an appropriate time necessary to perform the deleting or writing operation acquired from the vehicle controller when deleting or

writing operation is being performed, the accuracy of the offline determination is improved.

[0016]

[Embodiment of the Invention]

A system for rewriting a program stored in a non-volatile memory of a vehicle controller will be described referring to the drawings. The present invention, however, is not limited to the system but is applicable to various systems for rewriting various data stored in a memory.

[0017]

FIG. 1 shows a general functional block diagram of a rewriting system according to the invention. The rewriting system comprises an ECU 10 and an external rewriting device 11. The rewriting device 11 is a rewriting device authorized by a manufacturer of vehicles on which the ECU 10 is mounted. By connecting the rewriting device 11 to the ECU 10 via a serial communication bus and operating the rewriting device 11, security for preventing information such as a program and data stored in the ROM 16 of the ECU 10 from being rewritten without proper authorization is released. Thus, the rewriting device 11 is allowed to rewrite a program and data stored in the ROM 16.

[0018]

The ECU 10 comprises a central processing unit 14 (hereafter referred to as a "CPU") including a microcomputer and associated circuit elements, ROMs 16 and 17 which are non-volatile memories and which store programs and data, a RAM 15 (Random Access Memory) which provides a work area for execution and which stores results of computations, and an input/output interface 18 for receiving signals from

various sensors 19 and transmitting control signals to various parts of the engine.

[0019]

Signals from various sensors 19 include an engine rotation speed, an engine water temperature, an intake air temperature, a battery voltage, and an ignition switch. Thus, based on a signal input from the input/output interface 18, the CPU 14 invokes a control program and data from the ROMs 16 and 17 to execute computations, and outputs the results to various parts of the vehicle via the input/output interface 18 to control various functions of the vehicle.

[0020]

The ECU 10 also comprises an interface 12. The interface 12 has a protocol for communication with the rewriting device 11 to enable serial communication between the ECU 10 and the rewriting device 11.

[0021]

The rewritable ROM 16 is a non-volatile memory from which stored data can be deleted and to which new data can be written. The rewritable ROM 16 can be, for example, a flash memory or an EEPROM. The non-rewritable ROM 17 is a non-volatile memory where stored data cannot be changed. The non-rewritable ROM 17 can be implemented by specifying a part of the memory area of a rewritable ROM (such as a flash memory or EEPROM) as an unchangeable area, or by using a mask ROM for which data is fixed during manufacturing and from or to which data can subsequently not be deleted or written. Alternatively, the ROM 17 can be implemented with a PROM to which data can be written only once.

[0022]

The ROMs 16 and 17 can be implemented as two memories that are physically separated. Alternatively, the memory area of a single memory may be divided into two areas so that one of the areas is used as a rewritable area, while the other is used as a non-rewritable area. In the latter case, for example, after a non-rewritable area in which a program or the like is stored has been specified in an EEPROM, a rewritable area is specified with start and end addresses in the unfilled space of the memory.

[0023]

A program P1, which is to be rewritten by the rewriting device 11, is stored in the rewritable ROM 16. Programs that implement an authentication part 33, an initialization part 34, a deleting part 35 and a writing part 36 are stored in the non-rewritable ROM 17. The authentication part 33 judges whether the rewriting device 11 is authentic. If it is judged that the rewriting device is authentic, the authentication part 33 releases the security. The initialization part 34 performs an initialization process for starting deleting and writing operation. The deleting part 35 deletes the program P1 that is an object of the rewriting operation. The writing part 36 receives a new program P2 from the rewriting device 11 and then writes it into the ROM 16.

[0024]

The ECU 10 also comprises a deleting time calculating part 37 and a writing time calculating part 38. The deleting time calculating part 37 calculates the time necessary to delete the program P1. A unit time of deletion, which can be expressed, for example, in blocks or bytes, depends on the type of the ROM. That is, a unit time of deletion is predetermined in accordance with the specification of the ROM 16. The deleting time

calculating part 37 calculates the deleting time DT based on the size of the program P1 and a unit time of deletion specific to the ROM 16.

[0025]

The writing time calculating part 38 calculates the time necessary to write the new program P2 received from the rewriting device 11. As is the case for deletion, a unit time of writing depends on the type of the ROM, and is predetermined in accordance with the specification of the ROM. The writing time calculating part 38 calculates the writing time WT based on the size of the program P2 and a unit time of writing specific to the ROM 16. The writing time may be calculated for the entire program P2 or for each partial program code of the program P2 received from the rewriting device 11.

[0026]

The rewriting device 11 comprises a security release requesting part 20, a rewriting initialization part 21, a deleting requesting part 23 and a deleting result requesting part 25, which are stored in a memory of the rewriting device 11 as programs. The security release requesting part 20 requests the ECU 10 to release the security so that rewriting to the rewritable ROM 16 of the ECU 10 is permitted. The rewriting initialization part 21 performs a process necessary to start deleting and writing operation. The deleting requesting part 23 requests the ECU 10 to delete the program P1 in the ROM 16, which is an object of the rewriting operation. The deleting result requesting part 25 requests the result of the deleting operation from the ECU 10 to determine whether the deleting operation is in progress or has been completed.

[0027]

The rewriting device 11 preferably comprises a deleting time acquiring part 22 to acquire from the ECU 10 the deleting time DT necessary to delete the program P1 stored in the rewritable ROM 16. For example, before or when the deleting requesting part 23 requests the ECU 10 to delete the program P1, the deleting time acquiring part 22 acquires from the ECU 10 the deleting time DT calculated by the deleting time calculating part 37.

[0028]

In another embodiment, the deleting time calculating part 37 may be provided in the rewriting device 11 to calculate the deleting time DT in the rewriting device. The rewriting device 11 may have a unit time of deletion specific to the ROM 16 and program P1 in advance or may request a unit time of deletion from the ECU 10. Thus, the rewriting device 11 can calculate the deleting time DT.

[0029]

The rewriting device 11 also comprises a writing requesting part 27, a writing result requesting part 29 and a data block assembling part 30, which are stored in a memory as programs. The data block assembling part 30 converts program codes of the new program P2, which is to be transferred to the ECU 10, into data blocks suitable for serial communication. The data block assembling part 30 divides the program that is to be transferred into partial program codes each having a predetermined length (for example, eight bits), and adds an address field to respective partial program codes to assemble serial data blocks. The address field includes a leading address of the ROM in which the partial program code is to be stored so as to notify the ECU 10 of the memory location in which the partial program code is to be stored.

[0030]

The writing requesting part 27 requests the ECU 10 to write the new program P2 into the rewritable ROM 16 and serially sends the data blocks for the new program P2 assembled by the data block assembling part 30. The writing result requesting part 29 requests the result of the writing operation from the ECU 10 to determine whether the writing operation is in progress or has been completed.

[0031]

The rewriting device 11 preferably comprises a writing time acquiring part 26 to acquire from the ECU 10 the writing time WT necessary to write the new program P2 into the rewritable ROM 16. For example, before or when the writing requesting part 27 requests the ECU 10 to write the program P2, the writing time acquiring part 26 acquires from the ECU 10 the writing time WT calculated by the writing time calculating part 38. In the embodiment, the writing time acquiring part 26 acquires the time necessary to write the partial program code transferred at a time, Alternatively, the writing time acquiring part 26 may acquire the time necessary to write the entire program P2.

[0032]

In another embodiment, the writing time calculating part 38 may be provided in the rewriting device 11 to calculate the writing time WT in the rewriting device. The rewriting device 11 may have a unit time of writing in advance or may request a unit time of writing from the ECU 10. Thus, the rewriting device 11 can calculate the writing time WT based on the size of the new program P2.

[0033]

The rewriting device 11 also comprises an offline determining part 31. The offline determining part 31 judges whether the communication is offline. The offline determining part 31 compares a response time of the ECU 10 to a request by the deleting requesting part 23 with a predetermined first determination time DT1 and determines that the communication is offline if the response time exceeds the first determination time DT1.

[0034]

In addition, when deleting operation is being performed in the ECU 10, the offline determining part 31 prohibits the determination of offline until the response time exceeds the first determination time DT1 and then reaches a predetermined second determination time DT2. As a result, an erroneous determination of offline due to a busy state where deleting operation is being performed can be avoided. More specifically, the offline determining part 31 compares a response time of the ECU 10 to a request by the deleting result requesting part 25 with the second determination time DT2 and determines that the communication is offline if the response time exceeds the second determination time DT2. The second determination time DT2 is a reference time used for determining that the communication is offline when the deleting part 35 is performing the deleting operation. The determination time DT2 is established to satisfy DT1 < DT2.

[0035]

In a similar way, the offline determination part 31 compares a response time of the ECU 10 to a request by the writing requesting part 27 with a predetermined first determination time WT 1 and determines that the communication is offline if the response time exceeds the first

determination time WT1. The value of the first determination time WT1 may be consistent with or different from the value of the first determination time DT1.

[0036]

In addition, when writing operation is being performed in the ECU 10, the offline determining part 31 prohibits the determination of offline until the response time exceeds the first determination time WT1 and then reaches a predetermined second determination time WT2. As a result, an erroneous determination of offline due to a busy state where writing operation is being performed can be avoided. More specifically, the offline determining part 31 compares a response time of the ECU 10 to a request by the writing result requesting part 29 with the second determination time WT2 and determines that the communication is offline if the response time exceeds the second determination time WT2. The second determination time WT2 is a reference time used for determining that the communication is offline when the writing part 36 is performing the writing operation. The determination time WT2 is established to satisfy WT1 < WT2.

[0037]

Preferably, when the deleting time acquiring part 22 acquires the deleting time DT, the deleting time DT is set in the second determination time DT2. Similarly, when the writing time acquiring part 26 acquires the writing time WT, the writing time WT is set in the second determination time WT2. Thus, when deleting or writing operation is being performed, since the determination of offline is made based on the deleting time or writing time optimized in accordance with the specification of the ROM, the time for determining the offline can be minimized, the accuracy of the

determination being improved. Alternatively, as is the case for the first determination time DT1 and WT1, the second determination time DT2 and WT2 may also be predetermined as fixed values.

[0038]

Referring to FIG.2, rewriting operation according to the rewriting system shown in FIG. 1 will be described. The rewriting operation is initiated, for example, by pushing a button provided on the rewriting device 11 after it has been connected to the ECU 10. Alternatively, the rewriting operation may be initiated by operating the ECU 10.

[0039]

At step 41, the security release requesting part 20 of the rewriting device 11 sends a signal to the ECU 10 indicative of a request for releasing security. The authentication part 33 of the ECU 10 responds to the signal and initiates an authentication process for confirming that the authorized rewriting device is connected. The authentication process can be carried out in an arbitrary manner. For example, the rewriting device 11 and the ECU 10 have security functions, respectively. Each of the rewriting device 11 and the ECU 10 calculates its own function value for a given same number. The function value of the rewriting device 11 is compared with the function value of the ECU 10. If the rewriting device is authentic, the function value of the rewriting device 11 would be the same as the function value of the ECU 10 because the rewriting device has the same security function as the ECU 10. If the two function values are the same, the ECU 10 sends a signal to the rewriting device 11 indicative of a permission of rewriting. Thus, the security is released.

[0040]

If rewriting is permitted, the rewriting initialization part 21 of the rewriting device 11 sends a signal to the ECU 10 indicative of start of rewriting. The initialization part 34 of the ECU 10 returns a signal to the rewriting device indicative of a permission of start of rewriting when ready for rewriting (step 42). The rewriting initialization part 21 sends a request to the ECU 10 for shifting to a rewriting operation mode. The initialization part 34 of the ECU 10 executes a process of shifting to the rewriting operation mode (step 43). The rewriting initialization part 21 queries the ECU 10 if the shift has been completed. If the shift has been completed, the rewriting initialization part 34 sends a signal to the rewriting device 11 indicative of completion of the shift (step 44).

[0041]

The deleting time acquiring part 22 of the rewriting device 11 requests the time necessary to delete the program P1. In response to the request, the deleting time calculating part 37 of the ECU 10 calculates the deleting time DT and sends it to the rewriting device 11 (step 45). The deleting time acquiring part 22 sets the acquired deleting time DT in the second determination time DT2. The deleting requesting part 23 of the rewriting device 11 requests the ECU 10 to delete the program P1. In response to the request, the deleting part 35 of the ECU 10 sends a signal indicative of start of deleting operation (step 46). If a response time of the signal indicative of start of deleting operation exceeds the first determination time DT1, the offline determination part 31 of the rewriting device 11 determines that the communication is offline.

[0042]

At step 47, the deleting result requesting part 25 of the rewriting device 11 requests the result of the deleting operation. The request for the

result of the deleting operation is repeatedly sent until the deleting result requesting part 25 receives from the ECU 10 a signal indicative of completion of the deleting operation. Alternatively, after a predetermined time is elapsed from the time at which the request for the deleting operation is sent, the request for the result of the deleting operation may be sent at a predetermined time interval. If a response time of the ECU 10 to the request for the result of the deleting operation exceeds the second determination time DT2, the rewriting device determines that the communication is offline. When the deleting operation of the program P1 stored the ROM 16 has been completed, the deleting part 35 of the ECU 10 sends a signal to the rewriting device 11 indicative of completion of the deleting operation.

[0043]

In the rewriting device 11, the new program P2 has been prepared by the data block assembling part 30 as serial data blocks. Assembling of the data blocks from the program P2 is typically performed before the security release request or the rewriting start signal is sent to the ECU 10. Alternatively, it may be performed immediately before step 47 or 48.

[0044]

The writing time acquiring part 26 of the rewriting device 11 requests the time necessary to write the new program P2. In response to the request, the writing time calculating part 38 of the ECU 10 calculates the writing time WT and sends it to the rewriting device 11 (step 48). The writing time acquiring part 26 sets the writing time WT in the second determination time WT2.

[0045]

At step 49, the writing requesting part 27 of the rewriting device 11 transfers a data block including a partial program code of the new program P2 to the ECU 10 together with a signal indicative of a request for writing operation. In response to the request, the writing part 36 of the ECU 10 sends a signal to the rewriting device 11 indicative of start of writing operation. The writing part 36 examines an address field of the data block received from the rewriting device 11 to write the partial program code included in the data block into the location of the rewritable ROM 16 that is indicated by the address value in the address field. A check mechanism may be provided for determining whether the address value in the address field of the data block is included in addresses of data deleted by the deleting part 35. If a response time of the signal indicative of start of writing operation from ECU 10 exceeds the first determination time WT1, the offline determination 31 determines that the communication is offline.

[0046]

The writing result requesting part 29 of the rewriting device 11 requests the result of the writing operation from the ECU 10 (step 50). The request for the result of the writing operation is repeatedly sent until the writing result requesting part 29 receives from the ECU 10 a signal indicative of completion of the writing operation. Alternatively, after a predetermined time is elapsed from the time at which the request for the writing operation is sent, the request for the result of the writing operation may be sent at a predetermined time interval. If a response time of the ECU 10 to the request for the result of the writing operation exceeds the second determination time WT2, it is determined that the communication is offline. When the writing operation has been completed,

the writing part 36 sends a signal to the rewriting device 11 indicative of completion of the writing operation.

[0047]

The writing requesting part 27 transfers a next data block to the ECU 10 if the completion signal indicates a normal end. The steps 49 and 50 are repeated until all the program code of the program P2 is written into the ROM 16. When writing of all the program codes has been completed, the writing requesting part 27 requests the ECU 10 to release the rewriting operation mode (step 51). In response to the request, the writing part 36 releases the rewriting operation mode.

[0048]

FIGS. 3, 4 and 5 are flow charts showing deleting and writing operation. The operation shown in FIG. 3 is carried out by the deleting time acquiring part 22, deleting requesting part 23, deleting result requesting part 25 and offline determination part 31. The operation shown in FIG. 4 is carried out by the writing time acquiring part 26, writing requesting part 27, writing result requesting part 29 and offline determination part 31.

[0049]

At step 60, the rewriting device 11 sends a signal indicative of a request for the deleting time to the ECU 10. When the deleting time DT is received from the ECU (step 61), the deleting time DT is set in the second determination time DT2 (step 64). The rewriting device 11 sends a signal to the ECU 10 indicative of a request for deleting operation (step 65).

[0050]

If there is no response from the ECU 10 at steps 61 and 66, it is determined whether the predetermined first determination time DT1 (for example, 30 milliseconds) has elapsed (steps 62 and 67). If the first determination time DT1 has not elapsed, the process returns to steps 61 and 66, respectively, and rewriting device 11 waits a response from the ECU 10 again. If there is no response until the first determination time DT1 has elapsed, it is determined that the communication between the rewriting device 11 and the ECU 10 is offline (steps 63 and 68).

[0051]

If there is a response from the ECU 10 at step 66, the rewriting device 11 sends a signal to the ECU 10 indicative of a request for the result of the deleting operation (step 70). If there is a response to the request from the ECU 10 (step 71), it is checked whether the response indicates completion of the deleting operation (step 72). If the response indicates completion of the deleting operation, the process proceeds to step 76. If the deleting operation is in progress and the response does not indicate completion of the deleting operation, the process returns to step 70, and the signal indicative of a request for the result of the deleting operation is sent to the ECU 10 again. Alternatively, the return to step 70 may be made after a predetermined period.

[0052]

At step 71, if there is no response from the ECU 10, it is checked whether the first determination time DT1 has elapsed (step 73). If the first determination time DT1 has not elapsed, the process returns to step 71, and the rewriting device 11 waits a response from the ECU 10 again. If there is no response until the first determination time DT1 has elapsed, it is checked whether the second determination time DT2 (for example,

400 milliseconds) has elapsed (step 74). If there is no response until the second determination time DT2 has elapsed, it is determined that the communication is offline (step 75).

[0053]

Thus, when deleting operation is being performed, the determination of offline is made based on the second determination time that is longer than the first determination time. As a result, an erroneous determination of offline when deleting operation is being performed can be avoided. In addition, the determination of offline can be made more accurately since the second determination time is predetermined in accordance with the specification of the ROM.

[0054]

At step 76, if the deleting operation ends normally, the process proceeds to step 80 in FIG. 4. If the deleting operation does not end normally, the process exits from this routine. Steps following the step 80 are showing a process regarding writing operation in the rewriting device. The offline determination in the writing operation is made in a similar way to the offline determination carried out in the deleting operation.

[0055]

At step 80, a signal indicative of a request for the writing time is sent to the ECU 10. The rewriting device 11 receives the writing time WT and sets it in the second determination time WT2 (step 84). The process proceeds to step 85, and a data block including a partial program code of the new program P2 is transferred to the ECU 10.

[0056]

At steps 81 and 86, if there is no response from the ECU 10 until the predetermined determination time WT1 (for example, 30

milliseconds) has elapsed, it is determined that the communication is offline (steps 83 and 88).

[0057]

If there is a response from the ECU at step 86, a signal indicative of a request for the result of the writing operation is sent to the ECU (step 90). If there is a response to the request, it is checked whether the response indicates completion of the writing operation (step 92). If the response indicates completion of the writing operation, the process proceeds to step 96. If the writing operation is in progress and the response does not indicate completion of the writing operation, the process returns to step 90, and the rewriting device 11 sends the signal to the ECU indicative of a request for the result of the writing operation again. The return to step 90 may be made after a predetermined period.

[0058]

If there is no response from the ECU at step 91, it is checked whether the first determination time WT1 has elapsed from the time at which the request for the result of the writing operation is sent (step 93). If the first determination time WT1 has not elapsed, the process returns to step 91, and the rewriting device 11 waits a response from the ECU again. If there is no response until the first determination time WT1 has elapsed, it is checked whether the second determination time WT2 (for example, 400 milliseconds) has elapsed from the time at which the first request for the result of the writing operation is sent (step 94). If there is no response until the second determination time WT2 has elapsed, it is determined that the communication is offline (step 95).

[0059]

Thus, when writing operation is being performed, the determination of offline is made based on the second determination time that is longer than the first determination time. As a result, an erroneous determination of offline when writing operation is being performed can be avoided. In addition, the determination of offline can be made more accurately because the second determination time is predetermined in accordance with the specification of the ROM.

[0060]

At step 96, if it is determined that the writing operation ends normally, the process returns step 80 to transfer the next data block. Thus, at step 97, if all the program codes of the new program P2 have been sent to the ECU, the process exits from this routine.

[0061]

FIG. 5 shows a flow chart of deleting and writing operation carried out in the ECU. If a signal indicative of a request for the deleting time is received at step 101, the deleting time DT is calculated and sent to the rewriting device 11 (step 102). If a signal indicative of a request for deleting operation is received at step 103, a signal indicative of start of the deleting operation is sent to the rewriting device (step 104), and the deleting operation is performed (step 105). If a signal indicative of a request for the result of the deleting operation is received from the rewriting device when the deleting operation is in progress or has been completed (step 106), a signal indicative of the result of the deleting operation is sent to the rewriting device (step 107). The result signal shows the state of the deleting operation, in such a manner that a value "1" indicates completion of the deleting operation and a value "0" indicates that the deleting operation is in progress.

[0062]

In a similar way, if a signal indicative of a request for the writing time is received from the rewriting device (step 111), the writing time WT is calculated and is sent to the rewriting device (step 112). If a data block of the new program P2 is received from the rewriting device at step 113, a signal indicative of start of writing operation is sent to the rewriting device (step 114), and a partial program code included in the received data block is written into the rewritable ROM (step 115). If a signal indicative of a request for the result of the writing operation is received from the rewriting device (step 116) when the writing operation is in progress or has been completed, the result of the writing operation is sent to the rewriting device (step 117). The writing result signal shows the state of the writing operation, in such a manner that a value "1" indicates completion of the writing operation and a value "0" indicates that the writing operation is in progress. The transfer of the program from the rewriting device to the ECU is executed for each data block. Therefore, steps 113 through 117 are repeated until all the data blocks of the program are received (step 118).

[0063]

[Advantageous Effect of the Invention]

According to the invention as defined in claim 1, an erroneous determination of offline when the vehicle controller is performing deleting or writing operation on a memory can be avoided.

[0064]

According to the invention as defined in claim 2, since an offline determination is made based on an appropriate time required for the

deleting or writing operation when deleting or writing operation is being performed, the accuracy of the offline determination is improved.

[Brief Description of the Drawings]

[FIG. 1] A block diagram showing a general view of a rewriting system according to one embodiment of the invention.

[FIG. 2] An operational procedure of a rewriting system according to one embodiment of the invention.

[FIG. 3] A flow chart showing deleting and writing operation in a rewriting device according to one embodiment of the invention.

[FIG. 4] A flow chart showing deleting and writing operation in a rewriting device according to one embodiment of the invention.

[FIG. 5] A flow chart showing deleting and writing operation in a vehicle controller according to one embodiment of the invention.

[FIG. 6] A flow chart showing conventional deleting and writing operation in a rewriting device.

[FIG. 7] A flow chart showing conventional deleting and writing operation in a vehicle controller.

[FIG. 8] shows a typical form of a CPU and a memory in a vehicle controller.

[Explanations of Referenced Numerals]

10 ECU	11 Rewriting device
12 Interface	14 CPU
16 Rewritable ROM	17 Non-rewritable ROM

[Document Name] Abstract

[Abstract]

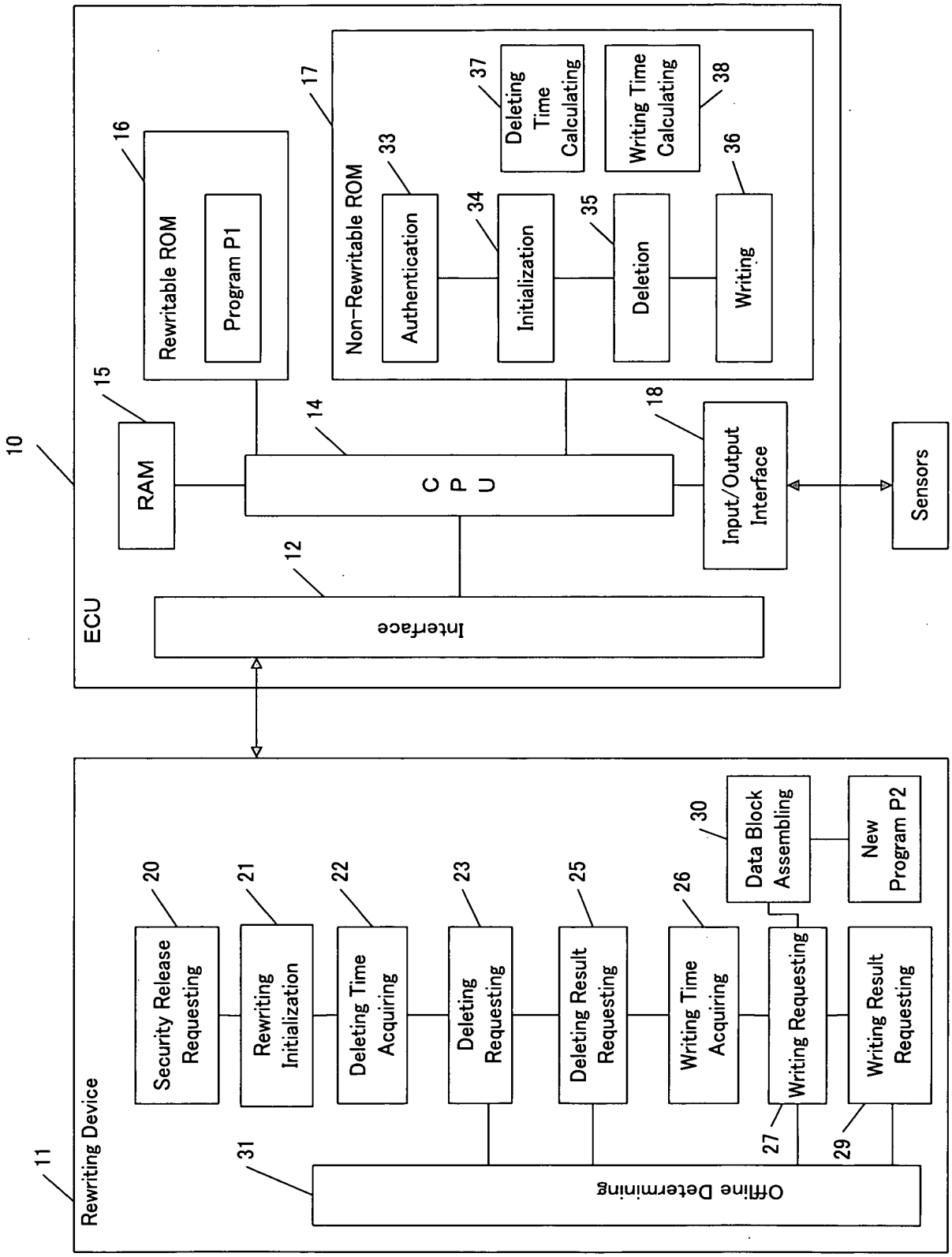
[Problems to be Solved] An erroneous determination of offline is avoided when deleting or writing operation on a memory of a vehicle controller is being performed.

[Means to Solve the Problems] A rewriting system for rewriting data stored in a memory of a vehicle controller with new data transferred from a rewriting device, the rewriting device comprising an offline determination means for determining that communication is offline if a response time of the vehicle controller exceeds a first predetermined time and an offline prohibiting means for prohibiting the offline determination until a response time of the vehicle controller exceeds the first predetermined time and then reaches a second predetermined time when deleting or writing operation on the memory is being performed. It is preferable to set the time required for the deleting or writing operation based on the specification of a ROM in the second predetermined time. Since the offline determination is prohibited until the time required for the deleting or writing operation has elapsed, an erroneous offline determination is avoided.

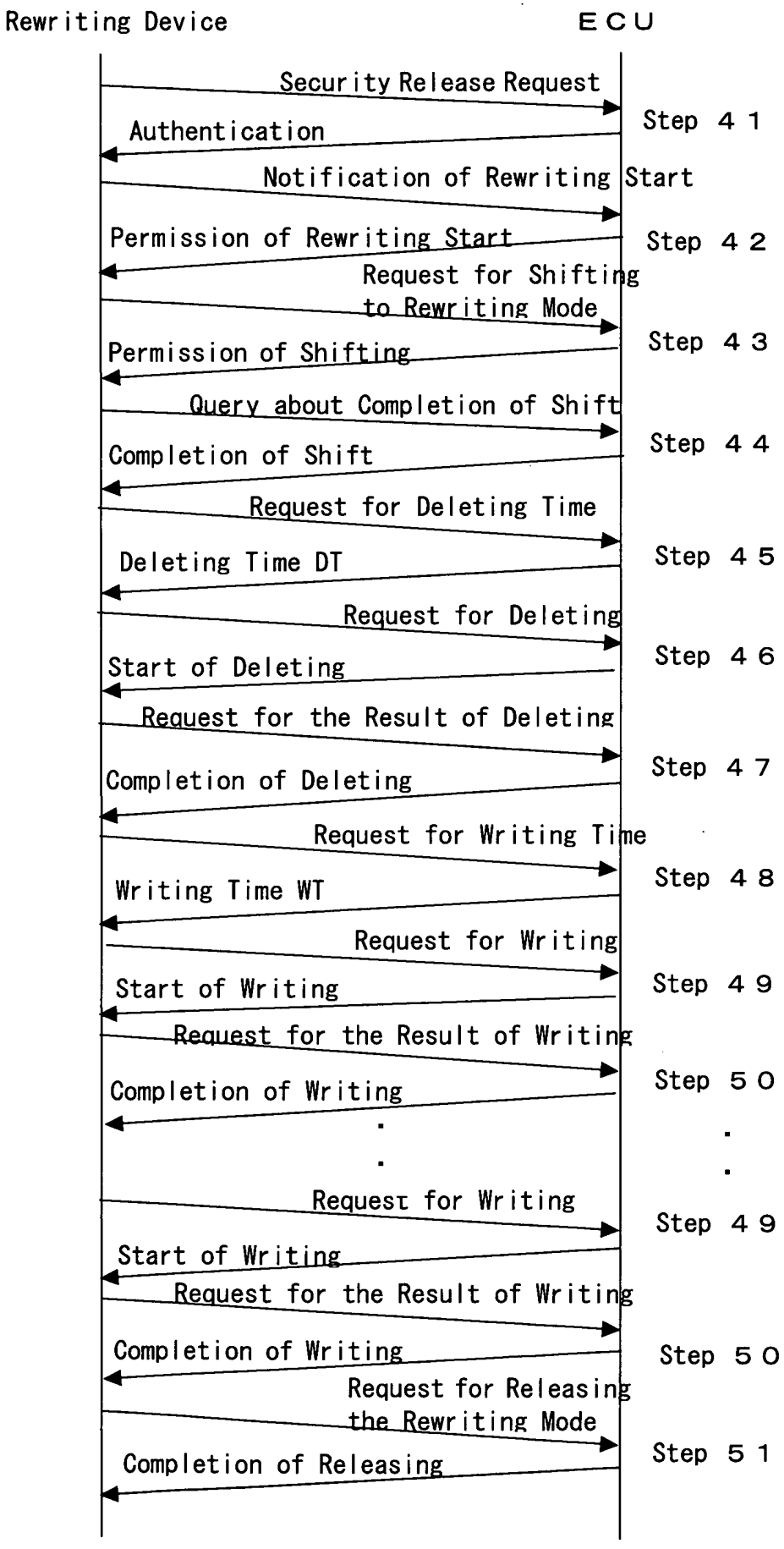
[Selected Figure] Figure 1

[Document Name] Drawings

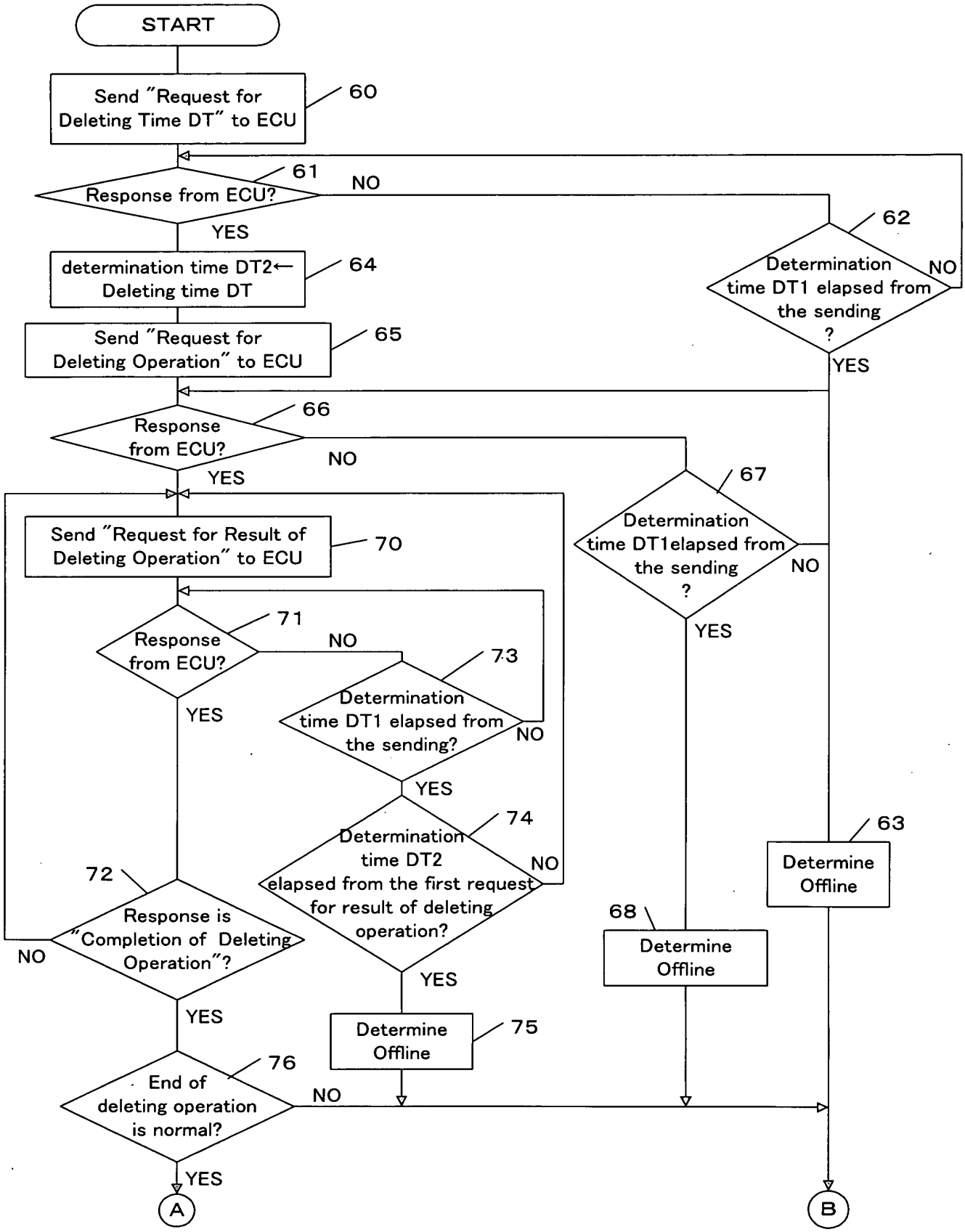
[FIG. 1]



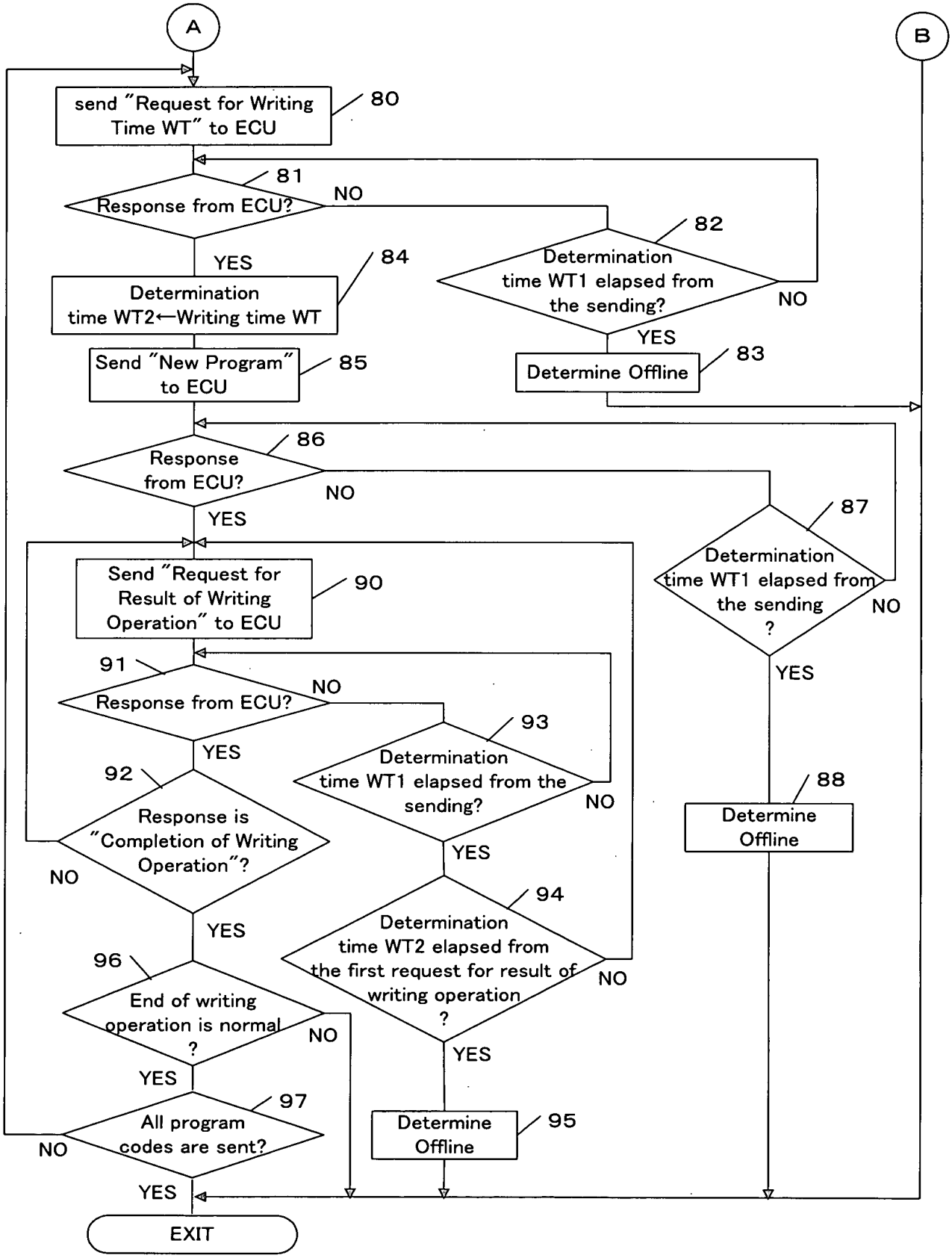
[FIG. 2]


Rewriting Device
ECU
Security Release Request
Authentication
Step 41
Notification of Rewriting Start
Permission of Rewriting Start
Step 42
Request for Shifting to Rewriting Mode
Permission of Shifting
Step 43
Query about Completion of Shift
Completion of Shift
Step 44
Request for Deleting Time
Deleting Time DT
Step 45
Request for Deleting
Start of Deleting
Step 46
Request for the Result of Deleting
Completion of Deleting
Step 47
Request for Writing Time
Writing Time WT
Step 48
Request for Writing
Start of Writing
Step 49
Request for the Result of Writing
Completion of Writing
Step 50
Request for Writing
Start of Writing
Step 49
Request for the Result of Writing
Completion of Writing
Step 50
Request for Releasing the Rewriting Mode
Completion of Releasing
Step 51

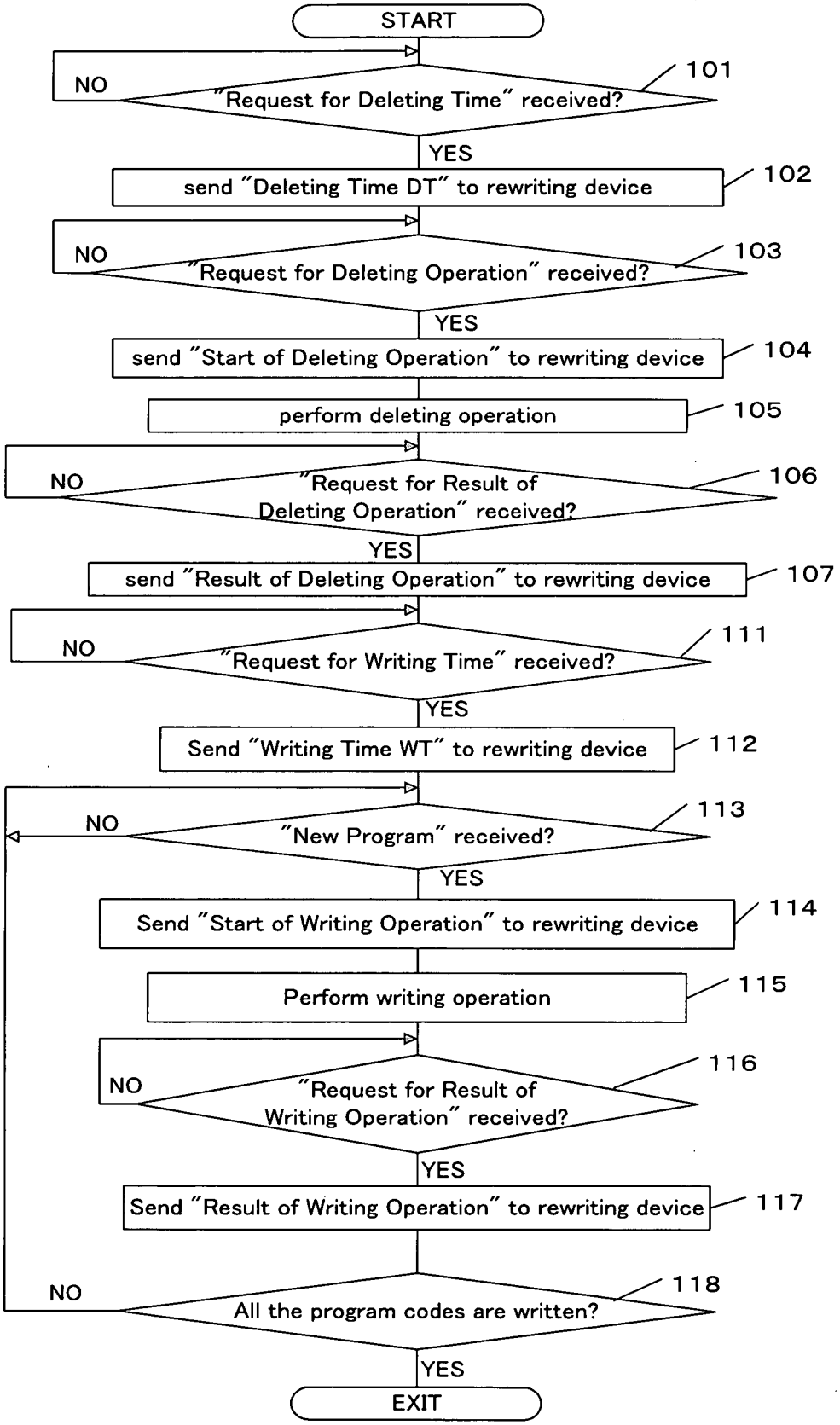
[FIG. 3]


START
Send "Request for Deleting Time DT" to ECU
60
Response from ECU?
61
NO
YES
determination time DT2← Deleting time DT
64
Send "Request for Deleting Operation" to ECU
65
Response from ECU?
66
NO
YES
Send "Request for Result of Deleting Operation" to ECU
70
Response from ECU?
71
NO
YES
Determination time DT1 elapsed from the sending?
73
NO
YES
Determination time DT2 elapsed from the first request for result of deleting operation?
74
NO
YES
Response is "Completion of Deleting Operation"?
72
NO
YES
Determine Offline
75
End of deleting operation is normal?
76
NO
YES
A
Determination time DT1 elapsed from the sending ?
62
NO
YES
Determination time DT1elapsed from the sending ?
67
NO
YES
Determine Offline
68
Determine Offline
63
B

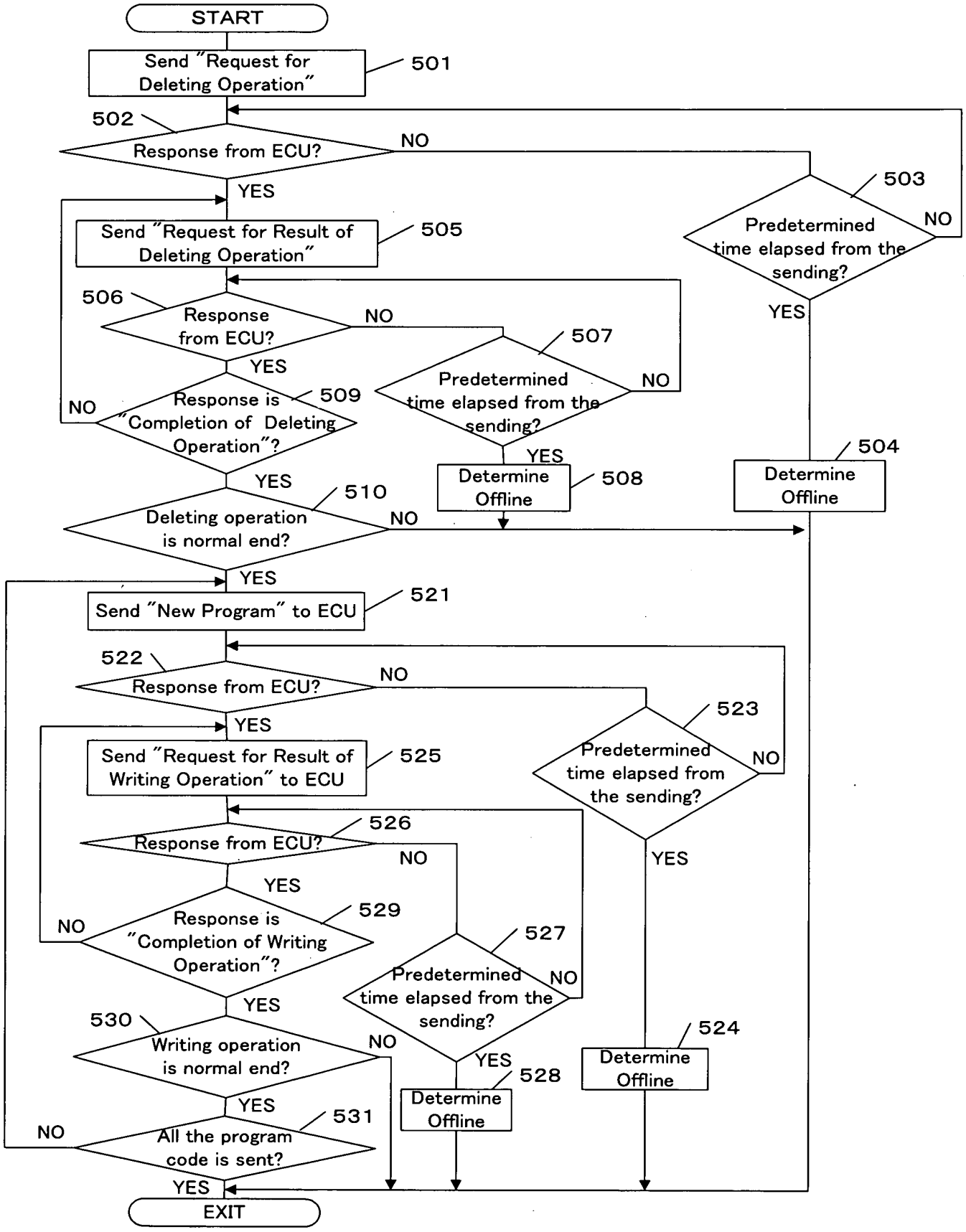
[FIG. 4]


A
B
send "Request for Writing Time WT" to ECU
80
81
Response from ECU?
NO
YES
82
Determination time WT1 elapsed from the sending?
NO
YES
84
Determination time WT2←Writing time WT
Send "New Program" to ECU
85
Determine Offline
83
86
Response from ECU?
NO
YES
87
Determination time WT1 elapsed from the sending ?
NO
YES
Send "Request for Result of Writing Operation" to ECU
90
91
Response from ECU?
NO
YES
93
Determination time WT1 elapsed from the sending?
NO
YES
92
Response is "Completion of Writing Operation"?
NO
YES
88
Determine Offline
94
Determination time WT2 elapsed from the first request for result of writing operation ?
NO
YES
96
End of writing operation is normal ?
NO
YES
97
All program codes are sent?
NO
YES
Determine Offline
95
EXIT

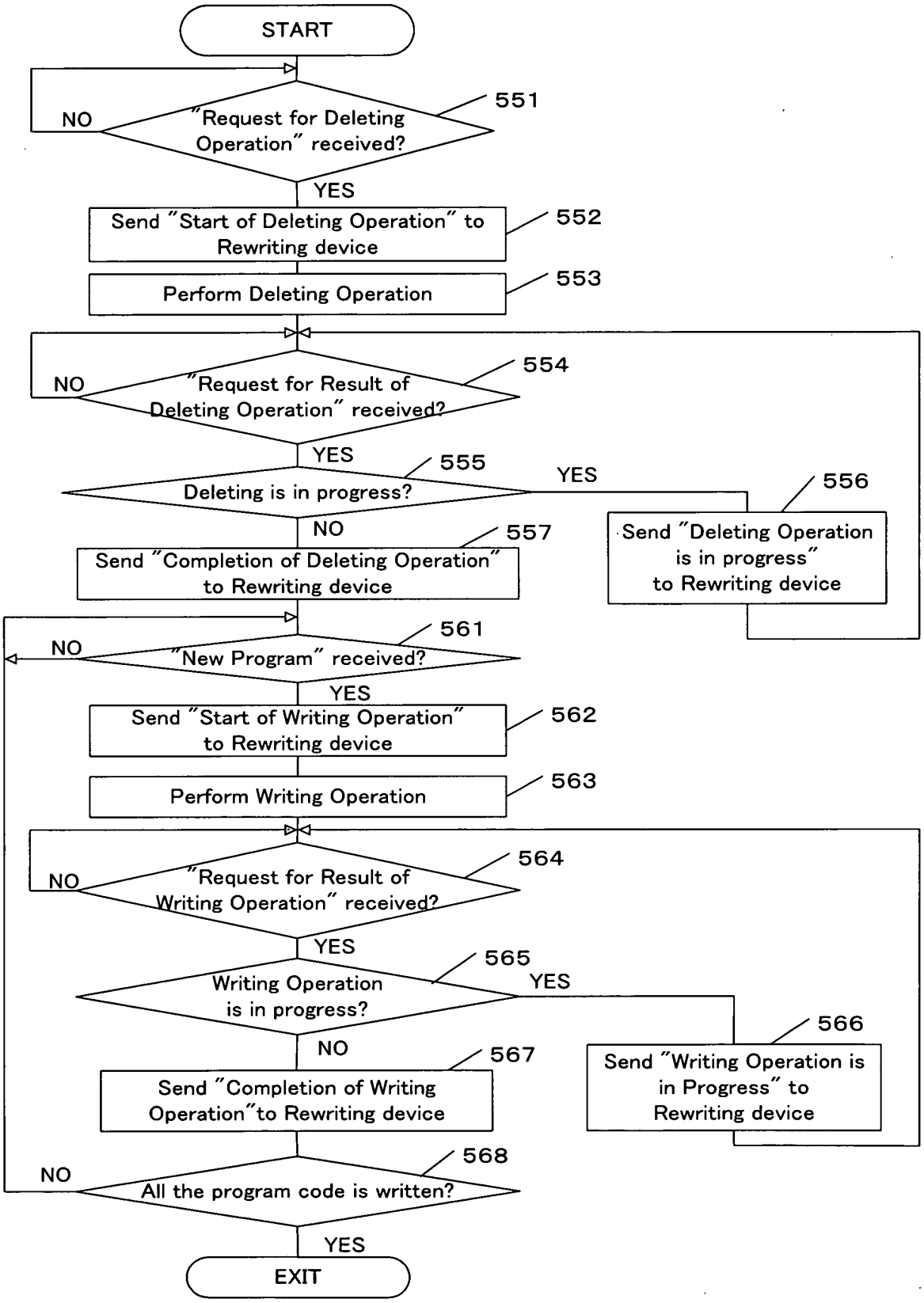
[FIG. 5]


START
101
NO
"Request for Deleting Time" received?
YES
send "Deleting Time DT" to rewriting device
102
NO
"Request for Deleting Operation" received?
103
YES
send "Start of Deleting Operation" to rewriting device
104
perform deleting operation
105
NO
"Request for Result of Deleting Operation" received?
106
YES
send "Result of Deleting Operation" to rewriting device
107
NO
"Request for Writing Time" received?
111
YES
Send "Writing Time WT" to rewriting device
112
NO
"New Program" received?
113
YES
Send "Start of Writing Operation" to rewriting device
114
Perform writing operation
115
NO
"Request for Result of Writing Operation" received?
116
YES
Send "Result of Writing Operation" to rewriting device
117
NO
All the program codes are written?
118
YES
EXIT

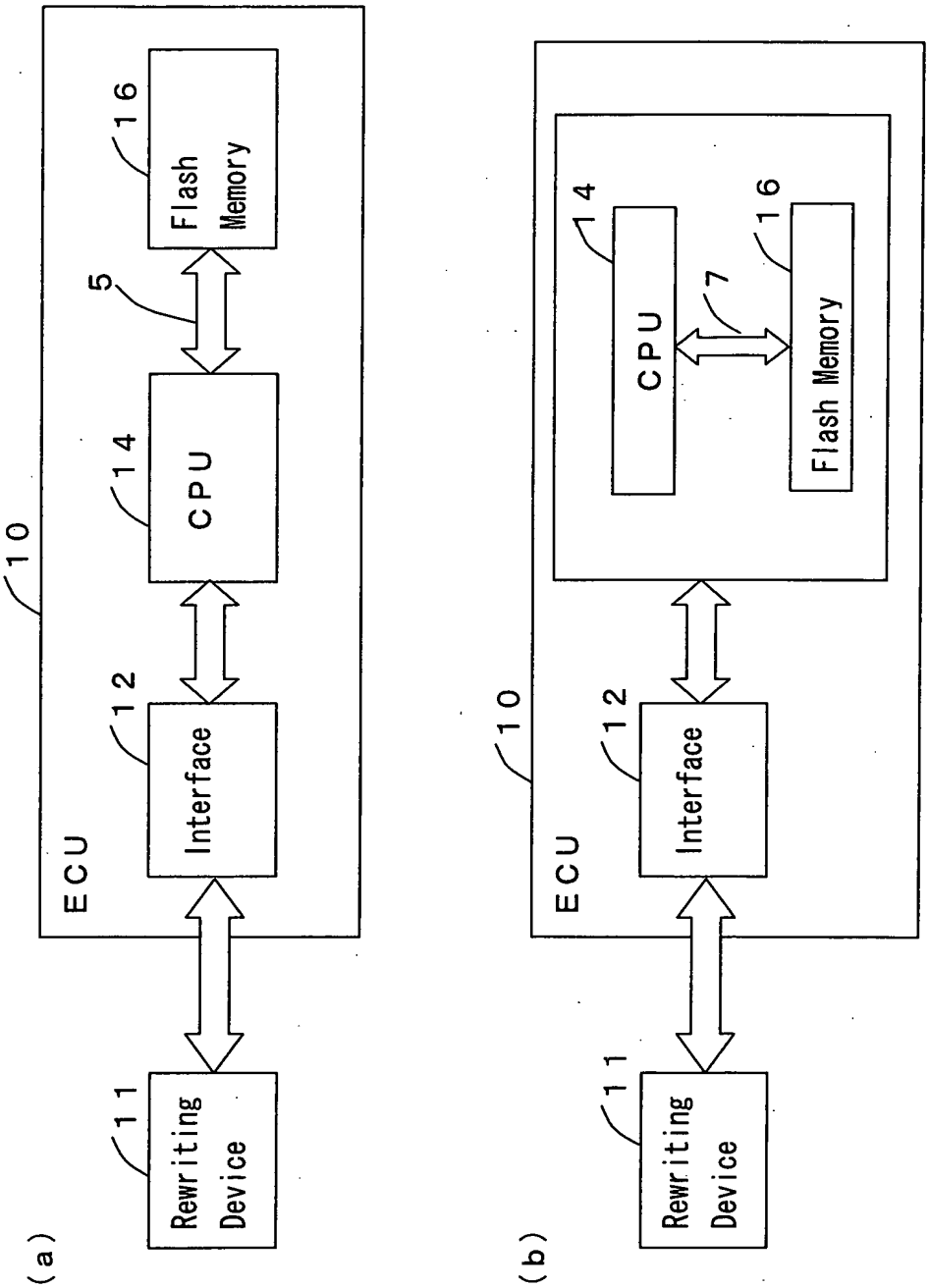
[FIG. 6]


START
Send "Request for Deleting Operation"
501
502
Response from ECU?
NO
YES
503
Predetermined time elapsed from the sending?
NO
YES
Send "Request for Result of Deleting Operation"
505
506
Response from ECU?
NO
YES
507
Predetermined time elapsed from the sending?
NO
YES
509
Response is "Completion of Deleting Operation"?
NO
YES
504
Determine Offline
Determine Offline
508
510
Deleting operation is normal end?
NO
YES
Send "New Program" to ECU
521
522
Response from ECU?
NO
YES
523
Predetermined time elapsed from the sending?
NO
YES
Send "Request for Result of Writing Operation" to ECU
525
526
Response from ECU?
NO
YES
529
Response is "Completion of Writing Operation"?
NO
YES
527
Predetermined time elapsed from the sending?
NO
YES
524
Determine Offline
528
Determine Offline
530
Writing operation is normal end?
NO
YES
531
All the program code is sent?
NO
YES
EXIT

[FIG. 7]


START
"Request for Deleting Operation" received?
NO
YES
551
Send "Start of Deleting Operation" to Rewriting device
552
Perform Deleting Operation
553
"Request for Result of Deleting Operation" received?
NO
YES
554
Deleting is in progress?
YES
555
Send "Deleting Operation is in progress" to Rewriting device
556
NO
Send "Completion of Deleting Operation" to Rewriting device
557
"New Program" received?
NO
YES
561
Send "Start of Writing Operation" to Rewriting device
562
Perform Writing Operation
563
"Request for Result of Writing Operation" received?
NO
YES
564
Writing Operation is in progress?
YES
565
Send "Writing Operation is in Progress" to Rewriting device
566
NO
Send "Completion of Writing Operation"to Rewriting device
567
All the program code is written?
NO
568
YES
EXIT

[FIG. 8]


(a)
ECU
10
Rewriting Device
11
Interface
12
CPU
14
5
Flash Memory
16
(b)
ECU
10
Rewriting Device
11
Interface
12
CPU
14
7
Flash Memory
16